US FLAMETHROWER TANKS OF WORLD WAR II

STEVEN J. ZALOGA ILLUSTRATED BY RICHARD CHASEMORE

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NEW VANGUARD 203

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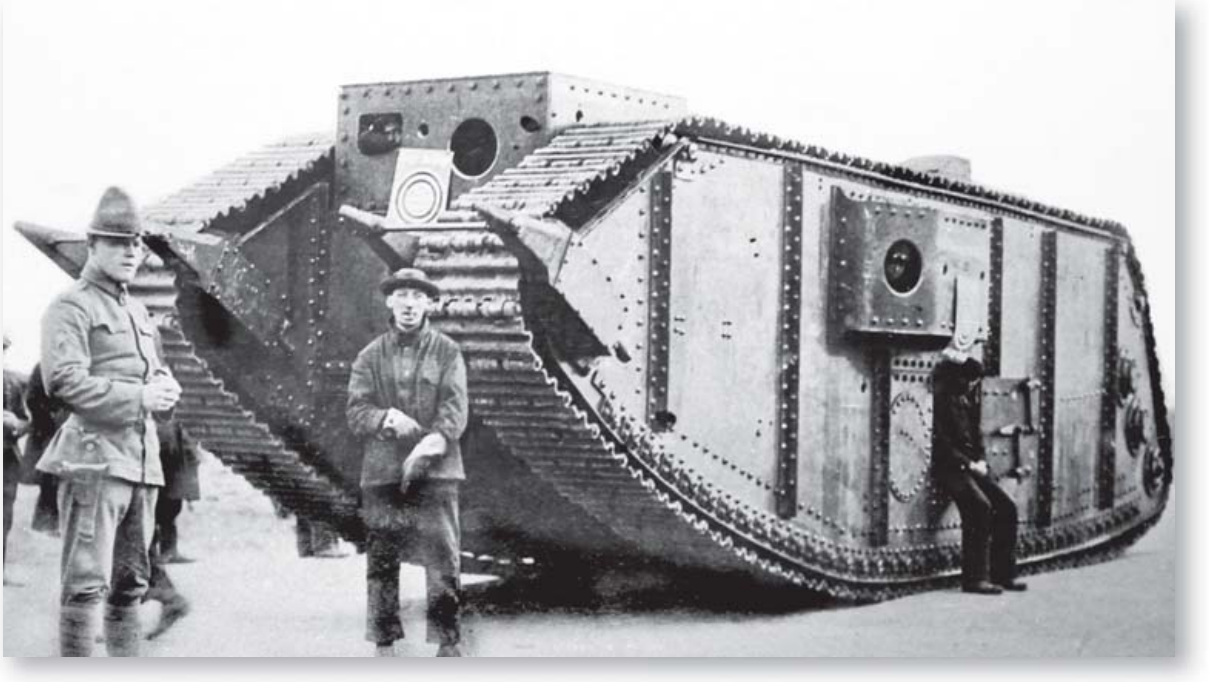
US FLAMETHROWER TANKS OF WORLD WAR II

INTRODUCTION AND ORIGINS

Fire has been a weapon since antiquity, but the modern flamethrower did not appear until World War I. The US Army was skeptical of the value of this weapon, and slow to recognize the tactical utility of a tank-mounted flamethrower. Much of the impetus for the World War II programs came from combat units in the Pacific theater, which began to develop improvised tank flamethrowers in 1943. When the geographic focus of the Pacific fighting shifted in 1944 from the tropical jungles of the South Pacific to the coral and volcanic islands of the Central Pacific, the requirement for tank flamethrowers became more urgent. Japanese tactics began to favor attritional battle based on caves and underground defenses, and the flamethrower was the most effective weapon in attacking these fortifications. In contrast, the difference in German tactics meant that tank flamethrowers played an insignificant role in the European Theater of Operations (ETO).



The Corps of Engineers' Steam Tank was the only US Army tank specifically developed with a flamethrower as its main weapon. Although demonstrated in France in 1918, it arrived too late for production in World War I. (Patton Museum)

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The E1 flame gun of the Mechanically Transported Flame Thrower was powered by compressed nitrogen and the vehicle carried 72gal of flame fuel consisting of equal parts fuel-oil, kerosene, and gasoline. The weapon could project flame to a range of 55yd for about 35 seconds. (NARA)

The US Army developed three major types of tank flamethrowers in World War II: main armament flamethrowers, auxiliary flamethrowers replacing the bow machine gun, and auxiliary flamethrowers in roof periscope mounts. Although the auxiliary flamethrowers were the most numerous type, the main armament flamethrowers proved the most effective as a result of their range and volume.

Early American flamethrower tanks

American flamethrower tanks can be traced back to 1917. Maj Harold Adams of the Corps of Engineers developed a long-range flamethrower that used a steam boiler to atomize and propel a stream of fuel oil about 90yd. It was successfully demonstrated in November 1917, leading to a scheme to mount the device in a steam-powered tank as a weapon to attack German pillboxes. The Steam Tank was patterned on British rhomboid tank designs and was powered by a pair of Doble steam engines offering 500hp. The Flame Projector, Tractor Type, Mark I was mounted in the front of the tank and there were sponsons on either side with .30cal machine guns. In September 1918, it was dispatched to France and demonstrated to Gen John Pershing, the commander of the American Expeditionary Force (AEF), near his headquarters at Chaumont. The concept was belittled by Col Amos Fries, the AEF Chemical Officer, who stated that "the use of liquid fire or flame projectors is rapidly going out of date in all the armies. The labor, expense, and danger to the troops themselves using the apparatus are so great as to make other means of attack preferable in practically all cases." In the event, the war ended before any production could begin.

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The Mechanized Flame Thrower E2 was built at Ft Knox on an obsolete M2 medium tank. Lingering mechanical problems with the design discouraged Armored Force support of the venture. (NARA)

After the war, flame weapon development was concentrated under the new Chemical Warfare Service (CWS). As it happened, the CWS was originally headed by Amos Fries, who made no secret of his disdain for this type of weapon. A post-war CWS study concluded that "all in all, the flame thrower was one of the greatest failures among the many promising devices tried out on a large scale during the war." As a result, there was no development of flamethrowers for the US Army through the interwar years.

After years of neglect, in 1940 the CWS began to reconsider the value of tank-mounted flamethrowers based on press reports about Italian and German flamethrower tanks, and on May 28, 1940 the Army approved the development of a "Mechanically Transported Flame Thrower." The CWS at Edgewood Arsenal in Maryland was unable to secure any modern tanks, and so the E1 flame gun was mounted on an obsolete Cunningham T2 4.2in Mortar Mount Carriage. Initial trials in September 1940 revealed many technical problems with the design, and after improvements were made, the pilot was demonstrated to the Armored Force on October 16, 1940. The Armored Force wanted any such weapon mounted on a medium tank, so the expedient Cunningham Mount was abandoned.

A

M3A1 WITH M1A1 FLAMETHROWER, COMPANY A, 754TH TANK BATTALION, BOUGAINVILLE, JANUARY 30, 1944

During the attack on the "Hornet's Nest" east of the Torokina River on January 30, the flame tanks could not find the Japanese bunkers once the crew closed the hatches. Recognizing their predicament, SSgt Jessie Downey of the 132nd Infantry climbed on one of the tanks and began pointing out the bunkers to the crew. They handed him a sub-machine gun with tracer ammunition, and he began firing at the bunkers to identify them. In the course of the action, Downey was hit at least twice and sustained a serious chest wound, but continued his mission. He was later awarded the Medal of Honor for his action that day. The 754th Tank Battalion had a distinctive set of unit markings consisting of a geometric symbol for the company (triangle = Company A; circle = Company C), hash marks to the upper left for the platoons, and a vehicle number in the center of the symbol. Usually these were carried on the rear sides of the hull, sometimes repeated on the rear plate.

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The Mechanized Flame Thrower E3 pressurized the flamethrower using a pump powered by the engine of its host M3 medium tank. This complicated its operation and forced a redesign using a more conventional pressurized gas system. (Patton Museum)

Since none of the new M3 medium tanks were available for experiments, the CWS was provided with an older M2 medium tank at Ft Knox. The Mechanized Flame Thrower E2 consisted of a flame gun in the turret, replacing the usual 37mm gun, a pair of 60gal fuel cells on the floor of the tank, and three compressed nitrogen pressure tanks on the rear deck. Initial tests at Ft Knox were discouraging owing to many mechanical problems, and the formal trials for the Armored Test Board in September 1941 were a flop because of the system's unreliability. The board refused to support acceptance of the weapon for Armored Force use.

An "Ad Hoc Reviewing Committee" in early 1942 concluded that the mechanized flamethrower "was problematical" and that only the man-portable flamethrower was required for Army use. The CWS was hamstrung in its ability to develop mechanized flamethrowers by the policy of the Army Ground Forces (AGF), who would not authorize development programs unless they were based on "battle-need"– an explicit requirement by the combat arm that would use the weapon. Since the CWS was not authorized to field flamethrower units, it required the support of the Armored Force. While the Armored Force did not halt mechanized flamethrower development by the CWS, its skepticism of the value of such weapons undermined early CWS efforts. There were studies as to whether a tank-mounted flamethrower could be used in fighting other tanks, but this idea was rejected on account of the weapon's short range and the tank's protection against flame attack.

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A demonstration of the field expedient tank auxiliary flamethrower developed on New Caledonia in the autumn of 1943 and seen here fitted to the hull machine gun mount of an M3A1 light tank of Company B, 3rd Marine Tank Battalion on October 10, 1943. (NARA)

The next Mechanized Flame Thrower E3 was mounted on the M3 medium tank. To avoid the need for a set of compressed-air tanks to propel the fuel, the E3 system used a rotary pump powered off the tank's engine. Trials of the E3 in the summer of 1942 were discouraging because the pump required the driver to operate the engine in a very narrow power range, and the pump's rotor blades broke down the thickened fuel. After poor results at Armored Force Board trials, the E3 was redesigned to use pressurized air. But by this time, the Armored Force was growing exasperated with the idea of a flamethrower as the main armament for a tank. However, it was willing to support the development of a smaller flamethrower that could be used as auxiliary armament in place of the usual bow machine gun.

Although the CWS was the principal development agency for US Army flamethrowers, the Office of Scientific Research and Development (OSRD) had a broader mandate to study technology that might be used by the War Department. The OSRD's National Defense Research Committee (NDRC) had begun to examine technical developments in Britain as part of its role in sponsoring technological innovation. The British Petroleum Warfare Board was undertaking a substantial flamethrower program, and the NDRC received briefings on its progress. The NDRC was able to pursue flamethrower development in spite of AGF skepticism, and its involvement proved invaluable since it had broad contacts with industrial firms in the petroleum business such as the Shell Development Co and Standard Oil

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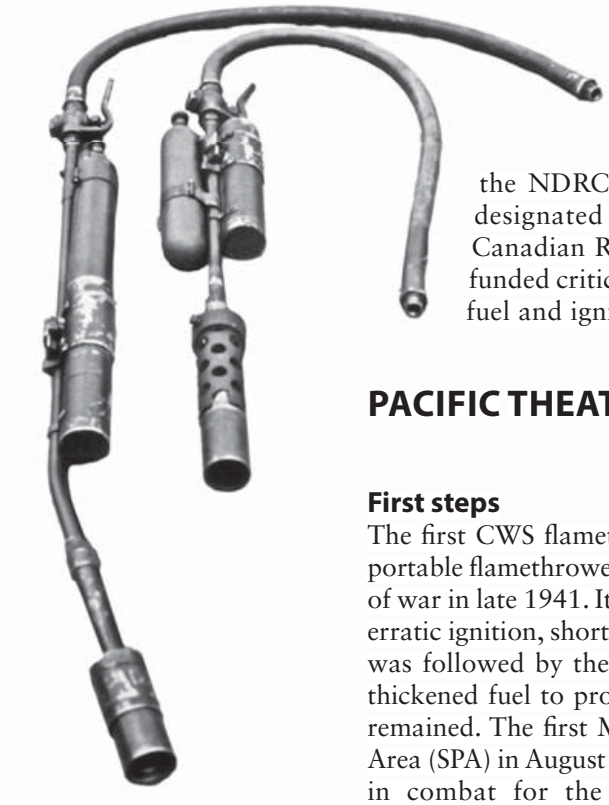

A detail view comparing the standard M1A1 portable flamethrower (left) and the modified auxiliary tank flamethrower (right) developed on New Caledonia in 1943 to equip M3A1 light tanks. (NARA)

Development Co, as well as the engineering departments of major universities such as MIT (Massachusetts Institute of Technology). In 1942, the NDRC sponsored a series of experimental flamethrowers designated Models A, B, C, and D, inspired by the British/Canadian Ronson. Besides work on actual weapons, the NDRC funded critical work on supporting technologies such as thickened fuel and ignition techniques.

PACIFIC THEATER

First steps

The first CWS flamethrower to be accepted for US Army use was the M1 portable flamethrower which entered production shortly before the outbreak of war in late 1941. It was an extremely troublesome weapon, suffering from erratic ignition, short battery life, and poor durability in damp conditions. It was followed by the improved M1A1 portable flamethrower which used thickened fuel to provide better range; however many reliability problems remained. The first M1A1 flamethrowers began to reach the South Pacific Area (SPA) in August 1942. The portable flamethrower was used successfully in combat for the first time during the Guadalcanal campaign on January 15, 1943 by US Army and Marine troops.

During the subsequent use of flamethrowers in the Solomons, as well as elsewhere in the Southwest Pacific Area (SWPA) such as in Buna and New Georgia, it quickly became apparent that the flamethrower operators were very vulnerable to Japanese small-arms fire due to the weight of the equipment and the visibility of the location once the flamethrower was ignited. An alternative was to mount these flamethrowers in tanks as a means to safely approach Japanese bunkers at the close ranges needed for the flamethrower to be effective. With no mechanized flamethrowers available through official channels, units in the South Pacific began to improvise.

The first known effort was made on New Caledonia in the late summer of 1943 when the 754th Tank Battalion attempted to fire portable flamethrowers out of the pistol ports of their M3A1 light tanks. This was not practical because of the confined space inside the light tank turret. The fighting on New Georgia against tenacious Japanese bunker defenses invigorated the effort to develop a more satisfactory mounting, and in August 1943, the US Army XIV Corps began an effort to adapt the M1A1

B

1: M3A1 SATAN, COMPANY D, 4TH MARINE TANK BATTALION, SAIPAN, JUNE 1944

The Satans had minimal markings during the Saipan fighting. Company D, 2nd Marine Tank Battalion had a company letter/number on the turret and a name starting with D on the hull. The 4th Marine Tank Battalion as seen here simply had a name on the turret, as well as a USMC registration number on the hull side in the usual chrome yellow.

2: E7-7 MECHANIZED FLAMETHROWER, 13TH ARMORED GROUP FLAMETHROWER DETACHMENT, LUZON, THE PHILIPPINES, APRIL 1945

The E7-7 mechanized flamethrowers were simply marked with names on the hull side in white. The two known examples were "Flaming Fanny" and "Fire Buggy".

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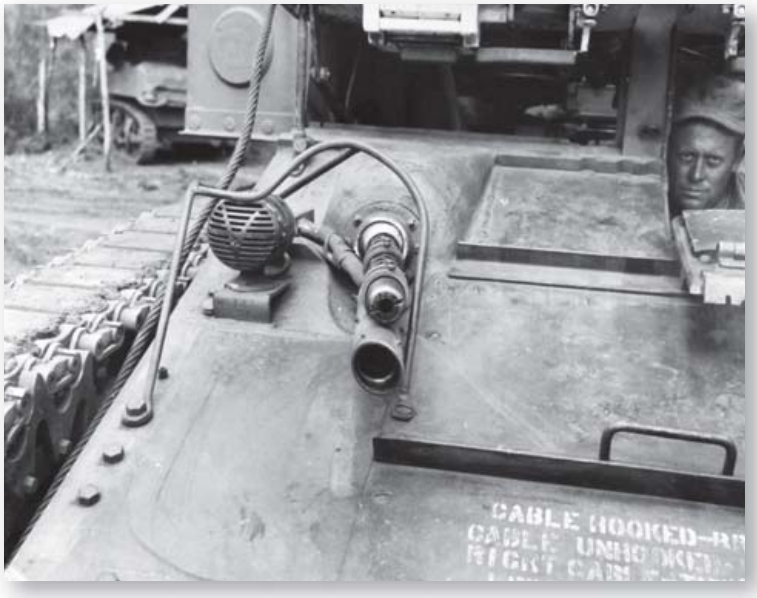
A M5A1 light tank of the 1st Marine Tank Battalion gives a demonstration of an M1A1 portable flamethrower installed in the bow machine gun mount on Goodenough Island, New Britain on November 6, 1943. (NARA)

Due to ignition problems with the M1A1 flamethrower, there were experiments on New Caledonia in March 1944 to mount the flame gun under the .30cal bow gun, using tracer fire to ignite the fuel. (NARA)



flamethrower to the bow machine gun mount in the M3A1 light tank. Demonstrations on New Caledonia in October 1943 led to a broad but scattered effort by many Army and Marine tank battalions based on these examples.

The first combat use of American flamethrower tanks took place during the fighting on Bougainville in the northern Solomons. On January 30, 1944, Company A, 754th Tank Battalion, supported Company C, 132nd Infantry, as part of the effort by the Americal Division to push its perimeter over the eastern side of the Torokina River and through a line of Japanese bunkers. Some of the M3A1 light tanks were fitted with bow flamethrowers, and these were used with some success in reducing several Japanese bunkers. A similar effort by the 1st Marine Tank Battalion on the Arawa peninsula on New Britain in February 1944 was less successful because the flamethrower igniters failed; one crewman finally ignited the stream by throwing a thermite grenade in front of the tank. In preparation for the landings on Kwajelein in February 1944, the CWS section of the Army's 7th Division mounted M1A1 flamethrowers on M5A1 light tanks and LVT amphibious tractors, incorporating an enlarged fuel tank that had been provided from Hawaii. These weapons were largely unsuccessful as their electrical systems became waterlogged during the landings.

The principal technical problem with the expedient tank-mounted flamethrowers was the unreliable ignition system of the M1A1. As a solution, one Army tank battalion cut a hole in the glacis plate of the M3A1 light tank in front of the bow machine gun mount for a modified flamethrower nozzle, and then used tracer fire to ignite the fuel. In May 1944, other Army units on New Caledonia developed a method of mounting the M1A1 alongside the .30cal machine gun so that the fuel stream could be ignited using tracers. The CWS informed local commanders that standardized auxiliary tank flamethrowers would soon be available from stateside and so the Sixth Army issued a directive in July 1944 to stop using the improvised flamethrowers.

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The first use of US flame tanks was by Company A, 754th Tank Battalion during the attack on the "Hornet's Nest" along the Torokina River on Bougainville on January 30, 1944. A few of their M3A1 light tanks were fitted with improvised M1A1 portable flamethrowers developed on New Caledonia. (NARA)

The E4-5 Mechanized Flamethrower

Reports from the Pacific theater made it clear that an auxiliary mechanized flamethrower was needed as quickly as possible. A conference of the major Army commands was held on October 11, 1943 at the Army War College and, as a result, on October 20 Army Service Forces authorized CWS to develop an auxiliary mechanized flamethrower designated E4-5. A new designation pattern for the CWS flamethrowers started with this weapon. The E4-5 designation indicated a flamethrower using the E4 fuel tank assembly coupled with the E5 flame gun. In the event that two fuel tanks were used, the designation was extended; for example the E4R2-4R3-5R1 consisted of the E4R2 and E4R3 fuel tanks coupled to an E5R1 flame gun.

The AGF requirement for the E4-5 stated the need for an auxiliary flamethrower with a range of 60–70yd when using thickened fuel, with a discharge rate of at least half a gallon of fuel per second. The E4-5 was based on the new M2 portable flamethrower, but used a much larger fuel tank, and was designed to fit in the standard machine-gun ball mount of the M4 medium tank. The first production contract was placed on December 16, 1943 for 82 units, a total that was continually increased through early 1944. The first production examples were dispatched to Ft Knox for trials in February 1944 and the Armored Force Board (AFB) issued its report on March 10, 1944. The E4-5 was generally found to be satisfactory, though there were numerous technical problems. For example, the AFB was dubious about mounting the weapon in the bow machine gun station and recommended that CWS develop an auxiliary flamethrower that could be mounted in the hatch periscope mount instead so that the bow machine gun could still be used.

In view of the urgent need for mechanized flamethrowers in the Pacific, AGF overruled the AFB and authorized the E4-5 for limited procurement until a more satisfactory design emerged. The E4-5 system underwent continual refinement during production in 1944, with modifications such as

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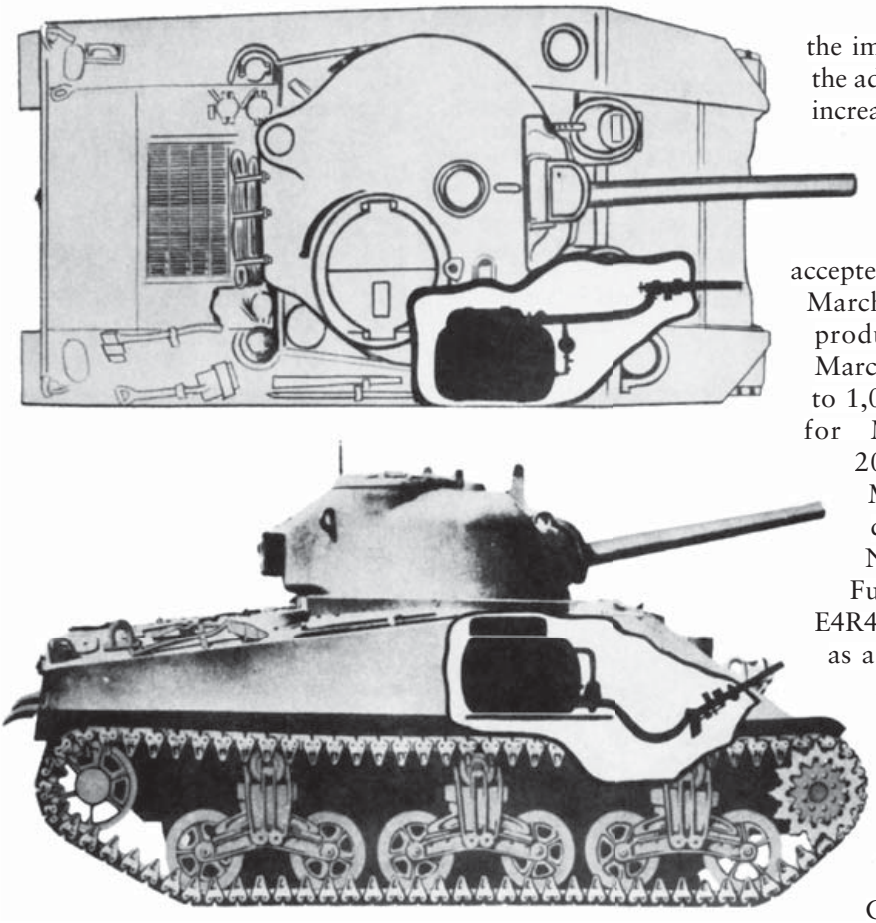

This illustration from the wartime technical manual shows the configuration of the original E4-5 auxiliary flamethrower with the single 25gal fuel unit in the right sponson and the flame gun in the bow machine gun mount. (NARA)

the improved E5R1 flame gun and the addition of a second fuel unit to increase capacity from 25 to 50gal. In the meantime, a similar system for light tanks, the E5-5, which used a smaller 10gal fuel unit, was also accepted for limited procurement in March 1944. A major increase in production was authorized on March 29, 1944, bringing the total to 1,039 E4R2-4R3-5R1 intended for M4 medium tanks and 200 E4R1-5R1 intended for M5A1 light tanks, with deliveries to be completed in November 1944.

Further refinements to the E4R4-5R5-5R1 led to its acceptance as a standard production type in April 1945 under the revised designation M3-4-3. The designation indicated sponson Fuel Tank Unit M3 with transmission Fuel Tank Unit M4 and Mechanized Flame Thrower Gun M3. A total of 1,020 M3-4-3 were produced in 1944 and 764 in 1945, making the E-4-5 mechanized flamethrower and its various derivatives the most numerous type of US mechanized flamethrower manufactured during the war.

Hawaiian hellfire

The delays in manufacturing a satisfactory tank flamethrower frustrated field commanders in the Pacific who wanted an immediate solution to the growing problem of Japanese bunker defenses. Lt Gen Robert Richardson, Central Pacific Area commander, urgently requested tank flamethrowers from the War Department and was promised 40 of the new E4-5 auxiliary flamethrowers by the start of the summer campaign in the Marianas. They failed to arrive in time.

C

LVT-4 WITH NAVY MARK I FLAMETHROWER, NAVY FLAMETHROWER UNIT #1, PELELIU, SEPTEMBER 1944

The LVT-4 were originally finished in the standard US Navy craft color, 5-0 Ocean Gray, a medium slate blue-gray. This faded to a light blue and led to complaints from Army units since the color was so visible once the amtracs reached land. A technical bulletin was issued in February 1944 authorizing the repainting of amtracs in olive drab, but the resources were seldom available for this in forward-deployed units in the Pacific. Some of the amtracs used by this unit may have been finished in olive drab, and a few had crude camouflage patterns, probably created using mud.

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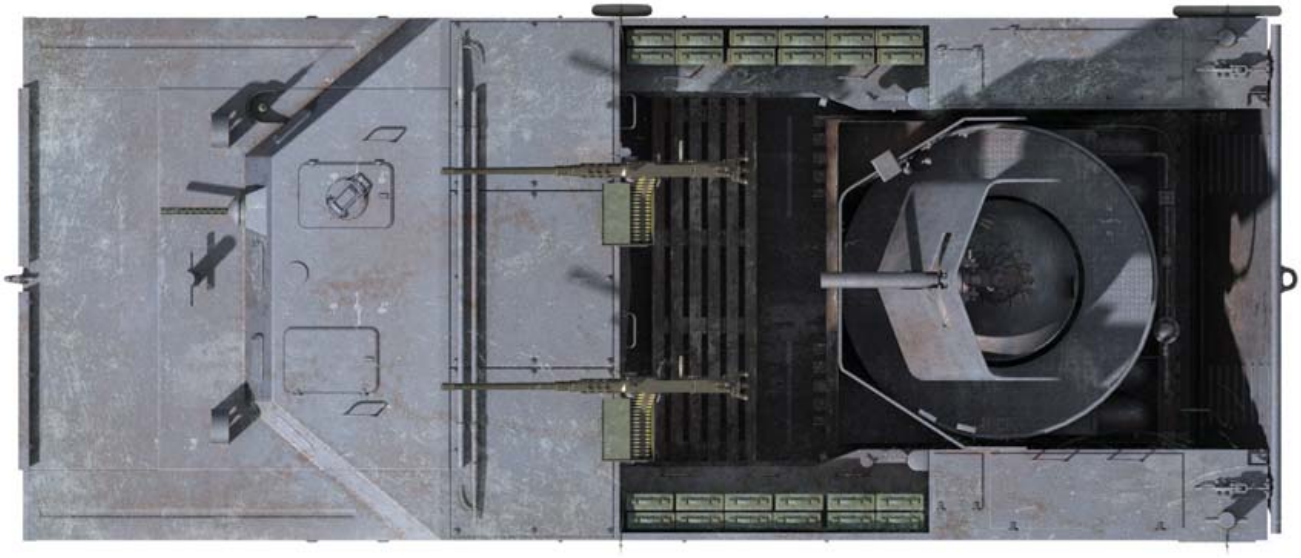

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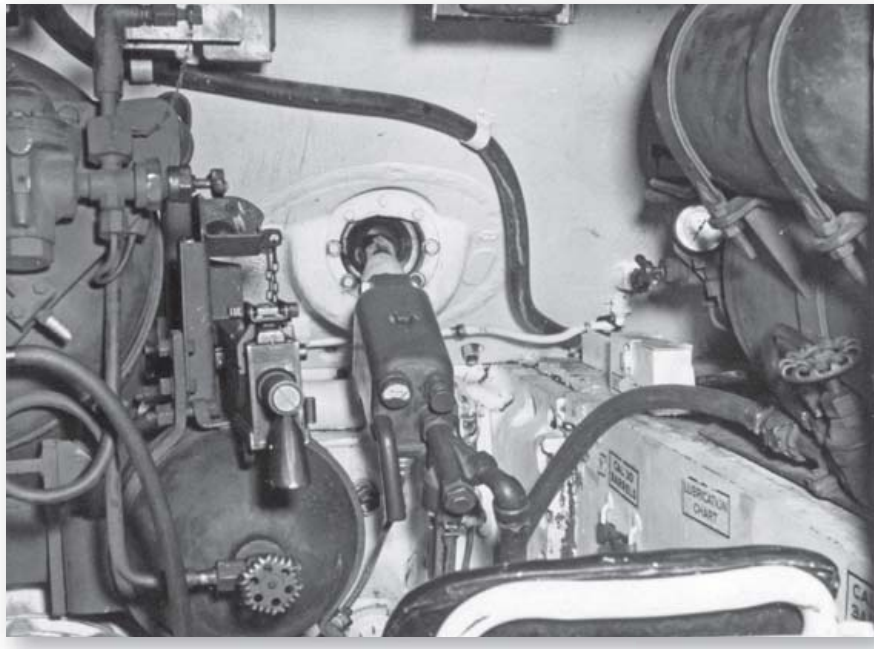

This shows the installation of an M3-4-3 auxiliary flamethrower inside an M4 tank. The M4 transmission fuel unit is to the left, the M3 flame gun in the machine gun ball mount, and the M3 fuel group to the right. The usual .30cal bow machine gun is stowed on the side so that it can be placed back in the ball mount if needed. (NARA)

Lt Gen Holland "Howling Mad" Smith, commander of the V Amphibious Corps assigned to the Marianas mission, began a flamethrower program based on reports from Tarawa about the value of flamethrowers in confronting Japanese fortifications. The V Amphibious Corps was aware of the Canadian Ronson flamethrower, and requested the dispatch of a supply as soon as possible. The Canadians were happy to oblige and 20 Ronsons arrived in Hawaii in January 1944 along with a small Canadian team headed by 1st Lt Trickey. They were sent to the Pacific Ocean Area-Chemical Warfare Service (POA-CWS) on Oahu headed by Col George Unmacht. This small office, teamed with the 43rd CWS Chemical Laboratory Company, would become the most productive and inventive development center for American tank flamethrowers during the war. Unmacht, in cooperation with Marine personnel, mounted the Ronson in a LVT-2 amtrac with a double set of fuel tanks. Although this was successfully demonstrated to V Amphibious Corps officers in February 1944, there was widespread appreciation that the vehicle was too vulnerable to small-arms fire. Since no medium tanks were available, Unmacht developed a mounting in the M3A1 light tank, codenamed the "Satan." This was demonstrated to senior V Amphibious Corps officers on April 15, 1944. "Howling Mad" Smith was so impressed with the display that he ordered the conversion of 24 light tanks into Satan flamethrowers in time for the landings on Saipan. The conversions were undertaken at Pearl Harbor by civilian and military workers and were completed on May 17, 1944.

The Satan was a modified version of the Canadian Ronson FUL Mark IV. The tank carried 170gal of fuel and used gas pressure to propel the flame to a range of 80yd for thickened fuel and 60yd for unthickened fuel. The improvised nature of the mounting limited the turret traverse. The internal volume of the tank was seriously compromised by the mounting, but there was widespread recognition that the Satan was much superior to previous improvisations. The two dozen tanks were split between the 2nd and 4th

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A flamethrower demonstration was held for the deputy commander of Army Service Forces, Lt Gen Wilhelm Styer on March 23, 1945 at Schofield Barracks, Hawaii by the POA-CWS staff; the general is standing immediately under the barrel of the experimental H1A-H5A flamethrower. The figure at the far right is Col George F. Unmacht, who led the Pacific flamethrower projects, and the officer pointing is Capt J. P. Bolanowski, who directed much of the flamethrower construction on Oahu. (NARA)

Marine Tank Battalions. Each Marine regiment on Saipan was supported by a tank company consisting of 18 M4 medium tanks, reinforced with a Satan flame platoon with four M3A1 Satan flame tanks and two M5A1 light tanks. The M5A1 light tanks served as escorts for the Satan tanks to deter Japanese infantry assaults.

Following the June 15, 1944 landings on Saipan, the Satans were used against a variety of targets. They proved to be especially useful against Japanese cave defenses, and were extensively used in the mop-up operations at the end of the campaign. On July 24, when the Marine 2nd and 4th Divisions were landed on neighboring Tinian, the two Satan companies followed. The terrain on Tinian was more favorable to tank operations than Saipan, and the Satans saw extensive combat use. The 4th Marine Tank Battalion lost a single Satan to a mine, and many other tanks suffered mechanical breakdowns due to their intensive use. The units were forced to cannibalize parts to keep the Satan force operating. The Marines gradually began to develop specialized tactics for dealing with Japanese cave defenses. The attack often started with an M4A2 medium tank blasting open the cave entrance with high-explosive fire, followed by a Satan attack to suppress any further Japanese resistance. This was frequently succeeded by close-assault teams equipped with flamethrowers and demolition charges. The flamethrowers proved to be unusually effective against cave defenses since the flame combustion near the cave entrance created a lethal concentration of carbon monoxide which suffocated any surviving Japanese troops in the caves. Post-attack inspections found that four out of five Japanese casualties to flame attacks were caused by carbon monoxide asphyxiation. On average,

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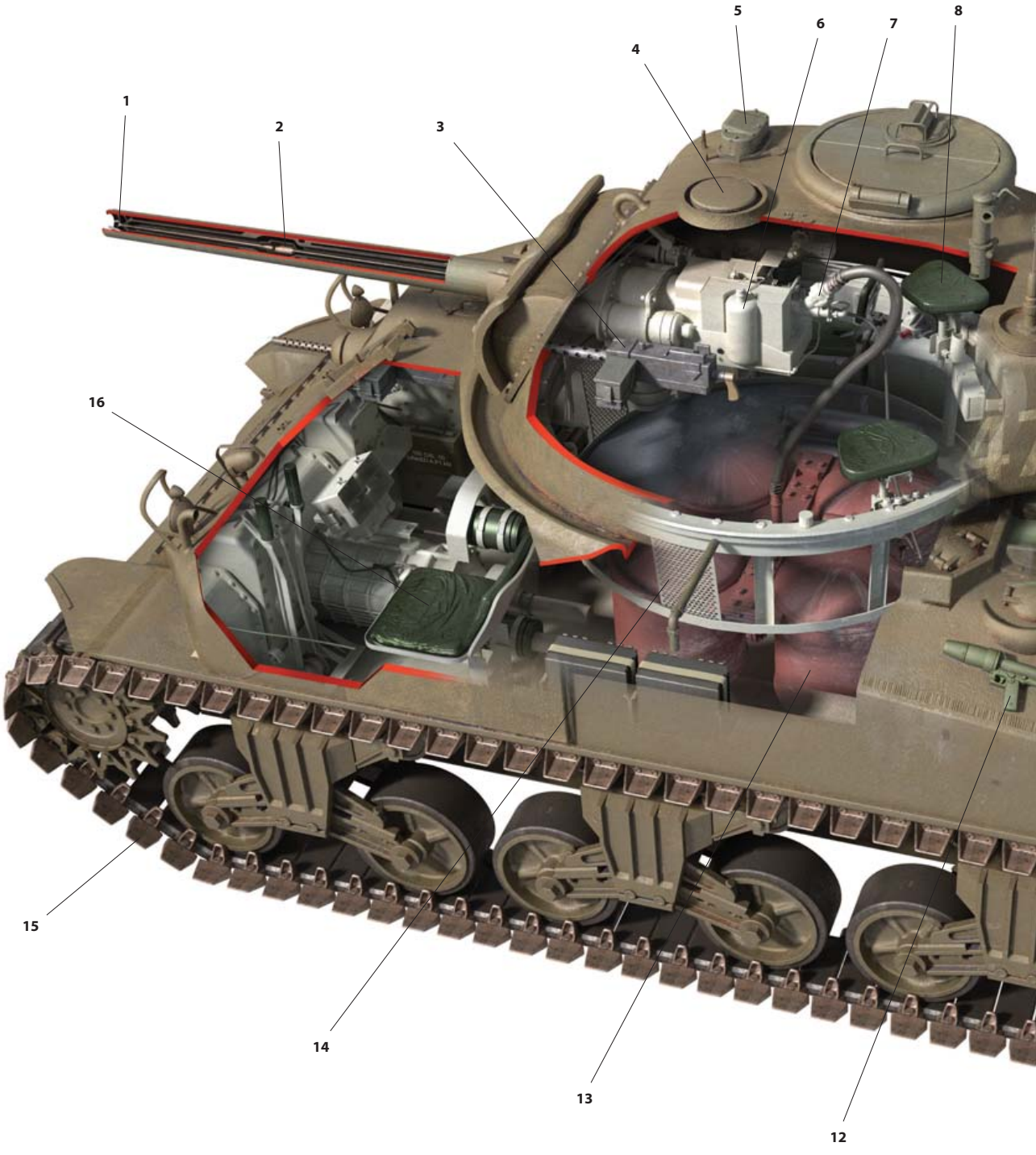
D

M4 POA-CWS H1 MECHANIZED FLAMETHROWER, 713TH ATF TANK BATTALION, OKINAWA, 1945



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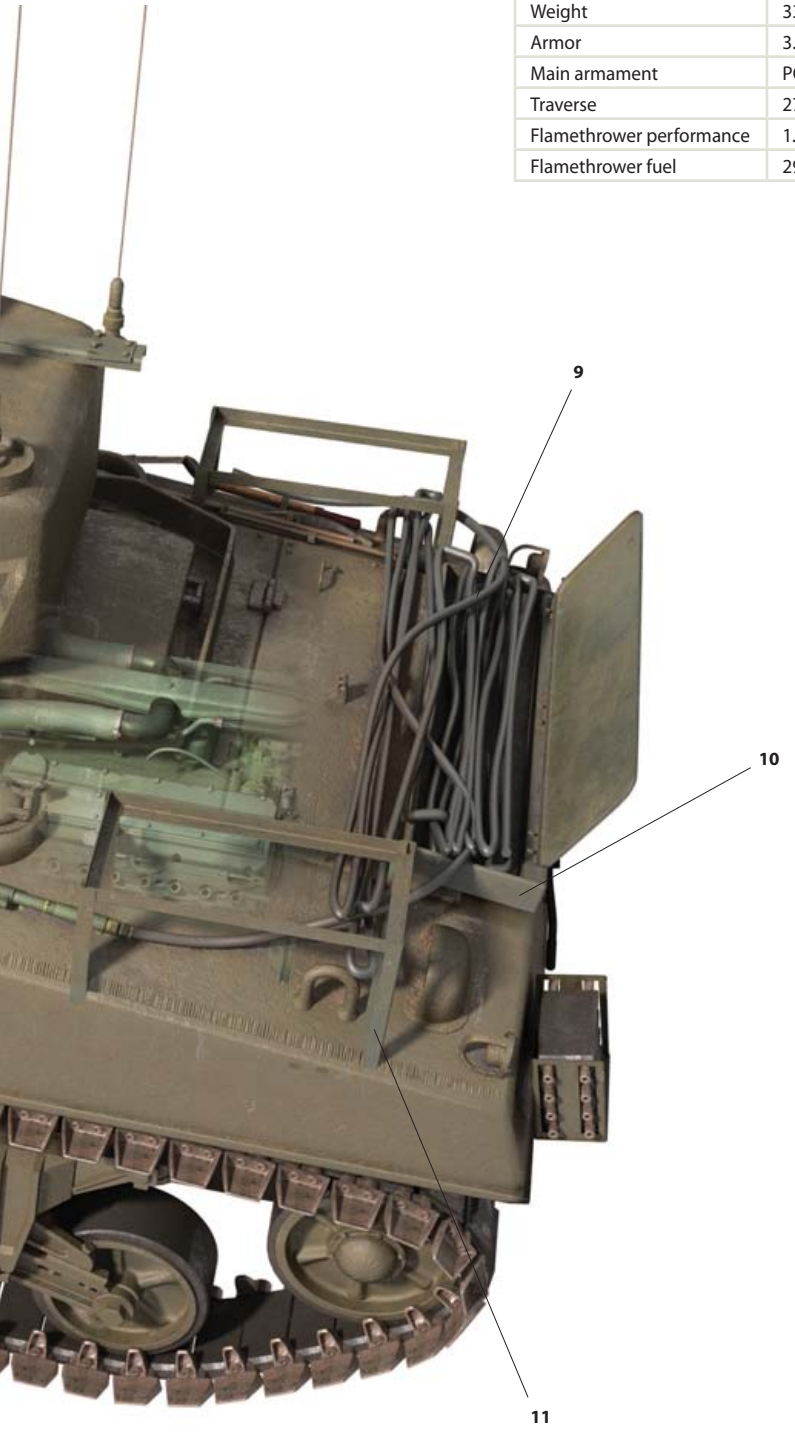
Technical data	
Crew	4
Length	19.3ft
Width	8.6ft
Height	9ft
Weight	33 tons
Armor	3.5in (gun shield), 2in (turret side, hull front); 1.5in (hull side)
Main armament	POA-CWS H1 flamethrower, compressed CO_2 propulsive gas
Traverse	270 degrees
Flamethrower performance	1.9 gal/sec, 150 sec endurance, 80yd range with thickened fuel
Flamethrower fuel	290 gal, 6% napalm, gasoline-electric ignition



KEY

1 Flame gun nozzle
2 Flame gun
3 Coaxial .30cal machine gun
4 Turret ventilation fan armored cover
5 Gunner's sight
6 Flame gun lead counter-weight
7 Main fuel hose and fuel feed
8 Commander's seat.
9 Assault flamethrower hose
10 Assault flamethrower stowage bin
11 Rack for assault flamethrower
12 M2 portable flame gun for assault flamethrower
13 Four flame fuel tanks
14 Modified turret basket
15 Extended track end connectors
16 Driver's station

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Among the first mechanized flamethrower projects by Unmacht's POA-CWS was this Canadian Ronson flamethrower fitted in the cargo bay of a LVT-2 amtrac. (NARA)

the flamethrower tanks used up a 55gal drum of fuel per day. During the Saipan fighting, 4th Marine Tank Battalion burned over 36,000gal.

Although flamethrower tanks had proven to be a useful addition to the Marine arsenal, there was no consensus on future needs. The 4th Marine Tank Battalion after-action report criticized the use of main-armament flamethrowers as too specialized and recommended that in the future a better solution would be an auxiliary flamethrower with adequate range and fuel capacity.

On July 24, the III Amphibious Corps assaulted neighboring Guam. Six M4A2 medium tanks of the 3rd Marine Tank Battalion had been fitted with the newly arrived E4-5 auxiliary flamethrowers and an additional 36 M1A1 portable flamethrowers had been adapted to tank use. The E4-5 first saw combat use during the fighting for Assan Point on July 25. The unit after-action report concluded that "the E4-5 is far superior to the M1A1 and M1 modified for use in tanks and the T/O [table of organization] allowance of eight per company of fifteen tanks is adequate. A flamethrower larger than the E4-5 is undesirable because of the limited space in the tank and necessity of removing armament."

The crew of Satan flamethrower D-21 "Dusty" of Company D, 2nd Marine Tank Battalion, commanded by 1st Lt Alfred Zavala (second from left), are posed here on Saipan in June 1944, displaying captured Japanese weapons. (NARA)

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The POA-CWS team in Hawaii mounted a Navy Mark I flamethrower inside an M3A5 medium tank in 1944, but the large size of the device made it difficult to adapt to the more common M4 medium tank. (NARA)

The Quickie Flamethrower

In November 1942, the NDRC awarded a contract to Standard Oil to design a large-capacity flamethrower dubbed Model Q. The Q stood for "Quickie" and, as the name suggested, the NDRC presumed that the Model Q would be simple to develop based on the previous experimental NDRC flamethrowers. The first test example was mounted on a trailer and demonstrated in January 1943. This led to a second contract to Standard Oil to adapt the Model Q to the M5A1 light tank, which was subsequently designated as the E7-7.

In the wake of the Tarawa fighting in November 1943, the US Navy began considering whether it might be worthwhile to mount long-range flamethrowers on landing craft to attack Japanese bunkers along the beachhead during amphibious attacks. The NDRC demonstrated the experimental Model Q to the Navy in December 1943–January 1944, which led to a contract to M. W. Kellogg Co and Standard Oil to manufacture 21 Mark I flamethrowers. These were designed as modular units weighing 3.2 tons that could be loaded into LCVP or LCM landing craft using a crane. The Mark I had a substantial 200gal fuel tank, supported by an array of pressurized nitrogen tanks to provide 2,000 psi, enabling the device to fire about 100yd using napalm-thickened fuel.

Five of the Mark I flamethrowers arrived in Hawaii in May 1944, and Unmacht's team mounted one of them in an M3A5 medium tank with the Q-gun fitted in place of the usual 37mm gun. In June 1944, another Navy

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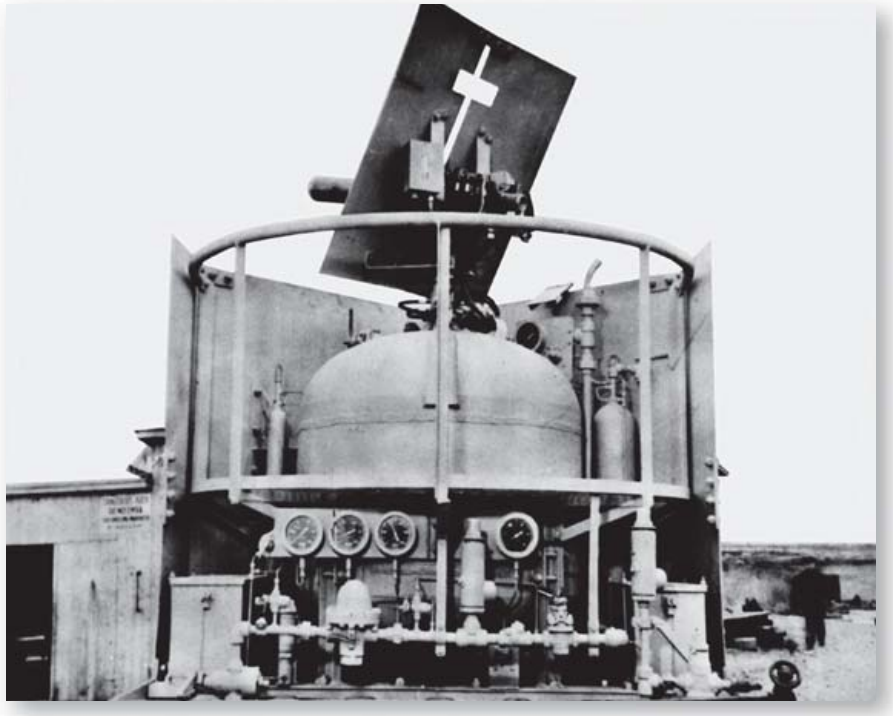

The Navy Mark I flamethrower was designed as a pallet load that could be lowered into landing craft for beach assaults. In the event, its only use in combat was on board LVT-4 amtracs during the Palaus campaign. (NARA)

flamethrower team was dispatched to the 1st Marine Amphibian Tractor Battalion on Guadalcanal, which was preparing for landings in the Palaus with its parent 1st Marine Division in September 1944. Instead of mounting the Mark I in a landing craft, the Navy mounted it in an LVT-4 amtrac on a wooden frame constructed in the rear cargo bay. The Mark I pallet could be transferred to another amtrac if it was necessary to repair a vehicle. The Marine flamethrower unit had a total of six Mark I flamethrowers and 19 LVT-4 amtracs for the mission. The 1st Marine Tank Battalion also had a small number of E4-5 auxiliary flamethrowers mounted in its tanks.

Most Marine officers were unaware of Navy Flamethrower Unit #1 and it remained idle for several days after the September 15, 1944 amphibious landing. Indeed the Mark I flamethrowers were only heavily used during the later stages of the Peleliu campaign. The Japanese defenders withdrew to the rugged crags further inland where numerous defensive caves had been created. The Mark I flamethrower amtracs were used in 61 days of fighting and were employed principally to burn out caves and other defenses. The unit after-action report estimated that it had burned out 100 caves, plus 25 bunkers and other defensive works, and had cleared about 40 areas with flame to support Marine and Army operations. The Mark I proved to be a far more powerful and robust weapon than any previous American flamethrower but the amtrac turned out to be a feeble choice as a transporter. The amtracs were not designed for sustained land operation, and suffered numerous mechanical breakdowns. Navy Flamethrower Unit #1 seldom had more than four flamethrowers operational at one time.

One of the more curious field adaptations of the Mark I took place during the fighting for the Umurbrogol Pocket. Since the amtracs could not approach closely enough to some Japanese defenses, engineers attached a 300yd fire-hose to the flamethrower unit, and then boosted the pressure along the way with

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A LVT-4 amtrac with Mark I flamethrower of the Navy Flamethrower Unit #1 in action on Ngesebus in September 1944 during the bitter fighting in the Palaus. (NARA)

additional pumps. This type of device was later designated as an "Assault Flamethrower." Gen Richardson learned of this tactic some days later and asked Unmacht's POA-CWS to refine this method of attack. As the fighting drew to a close, the detachment was finally withdrawn on November 28, 1944. The remaining equipment was handed over to the US Army's 323rd Infantry Regiment which used it for several more days of clean-up operations. The Army 154th Engineer Battalion created its own "assault flamethrower" using a fuel truck connected to fire-hoses and pumps for these operations.

Peleliu represented the most sustained use of US flamethrowers to date, in large measure due to shifting Japanese defensive tactics. The Imperial Japanese Army (IJA) had relied for most of the war on a "waterline defense" doctrine that emphasized the use of bunker defenses along the beach followed by "*banzai*" counterattacks further inland; however the fighting in the Central Pacific Area in 1943 at Tarawa and Kwajalein had made it clear that such tactics were unsuccessful. The new tactics emphasized the creation of deep defense lines depending on extensive fortification by tunneling into the coral and rock; *banzai* counterattacks were discouraged. The US Marine Corps and US Army found these types of fortifications were very costly to overcome, and one of the few effective weapons was the flamethrower. As a result, flamethrower tactics became increasingly central to US assault tactics in the final year of the Pacific war.

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The NDRC Model Q flamethrower was also experimentally mounted as the E7-LVT(A)1 in June 1944, later improved and redesignated under the CWS system as E14-7R2. Ten were built for trials but never saw combat use. (CWS Museum)

The Philippines

The Sixth Army operations in the Philippines saw very limited use of flame tanks. During the summer of 1944, XXIV Corps headquarters had requested that Unmacht's POA-CWS mount a flamethrower in a LVT(A)-1 amphibious tank and this used the same Ronson configuration as its previous Satan tanks. In addition, a further nine Satan conversions were undertaken on M3A1 light tanks. The XXIV Corps deployed its small flamethrower force on Leyte in the Philippines in October 1944. Resistance near the landing site was less extensive than in previous Pacific battles and the LVT(A)-1 with the Ronson was used to attack a single coconut-log bunker. The M3A1 Satan flamethrowers were employed by the 20th Armored Group, mostly on an improvised basis to help burn away foliage that was concealing Japanese defenses. The 603rd Tank Company had E4-5 auxiliary flamethrowers when deployed to Leyte, but they saw little, if any, use. The Army flamethrowers had very little impact on the Leyte fighting, in part owing to the wet autumn conditions.

By the time of the January 1945 landings on neighboring Luzon, a larger flamethrower force had been created. A number of E4-5 auxiliary flamethrowers were issued to US Army tank battalions, including the 755th Tank Battalion, and they also saw limited use in the urban fighting in Manila with the 603rd Tank Company.

The NDRC program to mount the Model Q flamethrower on the M5A1 light tank had resulted in the construction of four E7-7s in 1944. However, the US Army was no longer interested in main armament flamethrowers on light tanks by the time they were ready and development had shifted to medium tanks. A flamethrower detachment of four E7-7 tanks was dispatched to Luzon and assigned to the I Corps during the fighting in the Balete Pass area in April 1945 in support of the 25th Division. The E7-7 were used against a variety of Japanese field defenses, and the flamethrower unit proved to be far more durable and reliable than most of the improvised

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The four Mechanized Flamethrower E7-7s built on the M5A1 light tank were deployed to Luzon in the Philippines in April 1945 with the Flamethrower Detachment of the 13th Armored Group. (NARA)

designs used previously in the Pacific theater. However, the M5A1 light tank by this stage of the war was too lightly armored to survive against the newer Japanese antitank weapons, such as the 47mm gun, and there was widespread recognition that it would be better to mount such a flamethrower on a medium tank.

Iwo Jima

In the wake of the fighting on Peleliu, there was considerable concern about Japanese cave defenses on Iwo Jima, the next major US Marine Corps objective. While the Mark I flamethrower had proven very effective on Peleliu, the LVT-4 amtrac was far from ideal as a transporter. As a result, Fleet Marine Forces placed an urgent request to Gen Richardson to authorize Unmacht's POA-CWS to build some main armament flamethrowers on medium tanks for the upcoming landings.

This program was already under way based on POA-CWS experiments with mounting the Mark I in an M3A5 medium tank. Unmacht concluded that the weapon would not fit as designed into the shallower hull of the M4 medium tank, and, in the event, there were not enough of the Mark I guns available. In contrast, there was a steady supply of Canadian Ronson flamethrowers and parts. In the meantime, R. L. Iglehart, a civilian engineer with the Operation Research Section of POA, had come up with an alternative flamethrower design using gas pressure rather than springs in the fuel valves. One of the Iglehart flamethrowers was built by POA-CWS along with a modified Ronson with the Iglehart valve improvements. Officers of the Tenth Army complained that the short false gun tube used to enclose the flamethrower was unacceptable and should resemble the normal 75mm tube to prevent the Japanese from being able to identify flame tanks. Another iteration of the Ronson/Iglehart design was built using 75mm gun tubes, and this became the basis for the POA-CWS-H1 flamethrower. This system included 290gal of fuel

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Co-Ed, an M4A3 flame tank of Company C, 4th Marine Tank Battalion, firing its POA-CWS H1 flamethrower during the fighting in March 1945 on Iwo Jima. The battalion had four of these main armament flamethrower tanks. (NARA)

in four tanks under the turret, propelled by compressed carbon dioxide. It could fire 40yd with liquid fuel and 60–80yd with thickened fuel. A total of eight M4A3 medium tanks were converted in late 1944, and were issued to the 4th and 5th Marine Tank Battalions. This flamethrower was also widely called the CB-H1 (Construction Battalion-Hawaii-1) flamethrower after the Navy Seabees who undertook the conversions.

Another new flamethrower developed by POA-CWS in late 1944 was a periscope-mounted unit. This idea had been explored at Ft Knox using the M1A1 portable flamethrower. Two engineers involved in the Ft Knox project arrived in Hawaii in August 1944, and during a conference with officers of the 4th Armored Group offered a periscope flamethrower as an alternative option to the current auxiliary flamethrowers, to avoid the removal of the bow machine gun. POA-CWS developed the H1 Periscope Mount Flamethrower,

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M4A3, COMPANY C, 4TH MARINE TANK BATTALION, IWO JIMA, FEBRUARY 1945

The 4th Marine Tank Battalion had an energetic program to upgrade its tanks with appliqué armor and other improvements prior to the Iwo Jima landings, based on its combat experiences in the Marianas. This included wooden side armor to prevent the attachment of magnetic mines, bird-cages over the hatches to minimize the effects of satchel charges, and a water container on the engine deck for the supporting Marine riflemen. Company C had very plain markings consisting of the tank name and number in yellow. The new armor was overpainted in olive drab or dull green depending on what paint was available.

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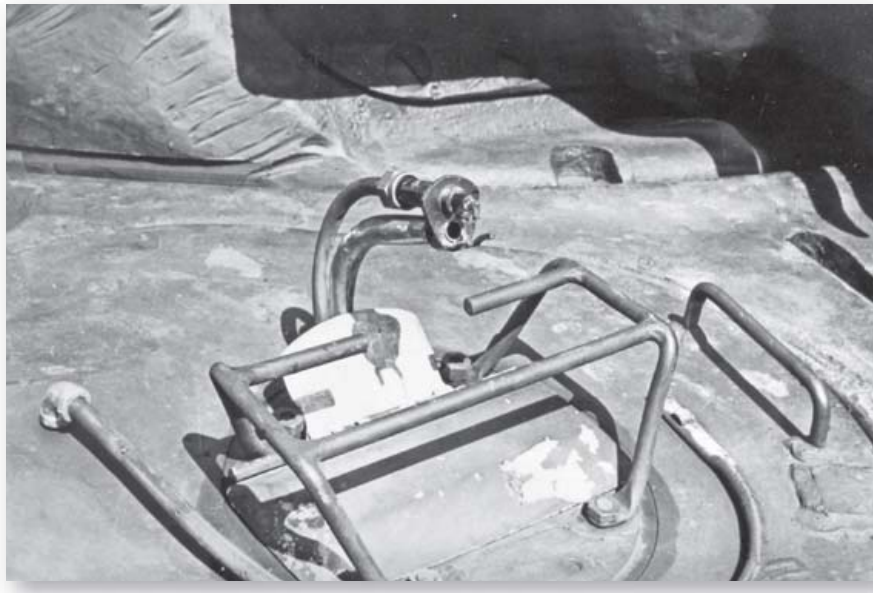
followed by the improved H1A and H1B flame guns; locally produced sponson fuel groups were called the H(E4R2) since they were based on the E4R2 design. A total of 176 of these periscope flamethrowers were built in Hawaii in 1945 using various fuel groups and gun combination, including the E4-H1, E4R2-H1A, H(E4R2) A-H1A and H(E4R2) A-H1B. These were intended primarily for the Tenth Army. The Marines were not happy with the placement of these flamethrowers in the co-driver's hatch because of fears that it would be vulnerable to Japanese magnetic mines placed on the hatch.

Prior to Iwo Jima, the POA-CWS also demonstrated the E4R2-5R1 auxiliary flamethrower to the Marines and Army. The Marines preferred the ignition system developed by POA-CWS for the periscope mount, and so began modifying the E4-5 with the improved features. The 4th Marine Tank Battalion had 24 E4-5 flamethrowers mounted in its tanks besides the four POA-CWS H-1 tanks, and the 5th Marine Tank Battalion also had a portion of its tanks fitted with the auxiliary flamethrowers.

Japanese defenses on Iwo Jima were based on a honeycomb of caves and bunkers built into the volcanic island. Flamethrowers were by far the most effective weapon against these defenses, and both portable and mechanized flamethrowers were a primary Marine weapon during the savage battle that began on February 19, 1945. The flame tanks were used in coordination with dozer tanks to help clear access to the Japanese defenses, and with regular gun tanks to provide fire support and prevent Japanese close-range infantry attack. The 5th Marine Tank Battalion flame tanks consumed 5,000–10,000gal of thickened fuel daily, and the main handicap was the lack of sufficient POA-CWS H1 main armament flame tanks. The arrival of the 3rd Marine Division as reinforcements did not help, as the 3rd Marine Tank Battalion lacked the main armament flame tanks, and was limited to the new E4R2-5R1 auxiliary flamethrowers.

The 5th Marine Tank Battalion after-action report concluded that "The flametank performed splendidly, and constantly overcame resistance which all other weapons had failed to silence." The commander of the 28th Marines, which had been supported by the 5th Marine Tank Battalion, called the flame



This is a close-up of the periscope auxiliary flamethrower built by POA-HWS in Hawaii and used during the fighting on Okinawa. It was usually mounted on the hatch above the bow-gunner, on the right front roof of the hull. (NARA)

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tanks the "best single weapon of the operation." The 9th Marines described the mechanized flamethrower as the most powerful weapon at their disposal. Their after-action report attributed its effectiveness to the ability of the flame stream to enter small pillbox apertures and cave openings, engulfing all contours and folds with fire; defenses that had withstood constant artillery, naval gunfire, and close-range 75mm tank gunfire succumbed to the POA-CWS H1. The V Corps commander identified the mechanized flamethrower as "the only effective means" of attacking the numerous pillboxes, bunkers, and fortified caves.

In contrast to the POA-CWS H1, the E4-5 auxiliary flamethrower was not well liked. "The short range of the small (E4-5) flamethrower rendered it next to useless... The E4-5 flamethrower has too little range, takes too long to refuel, and does not have sufficient duration of fire." Tanks fitted with the auxiliary flamethrowers developed the reputation of being death-traps, as some Marine tankers felt that mine and artillery damage was amplified by flamethrower fuel fires. The 5th Marine Tank Battalion recommended that in the future a Flame Tank Section of at least nine flame tanks be assigned to each battalion. The battalion suggested that the E4-5 be dropped, or, if an auxiliary flamethrower remained as standard equipment, that it be modified to permit the bow machine gun to remain.

Operation *Iceberg*: Okinawa

In August 1944, Unmacht's POA-CWS conducted a demonstration of the available flamethrowers to officers of the Tenth Army, earmarked for the next major amphibious landing on Okinawa. In view of the overwhelming success of flame tanks during the Iwo Jima battles, the POA-CWS workshops in Hawaii were ordered to construct as many of the main armament flamethrowers as possible. The Tenth Army in late August 1944 estimated that 223 would be needed, but this exceeded the available pool of tanks in the theater at the time. Instead, the Army's 713th Tank Battalion was converted into a provisional flamethrower battalion for the Okinawa operation with 54 M4 medium tanks fitted with POA-CWS H1. The magnitude of this construction effort required the organization of a Flame Thrower Group at Schofield Barracks, Oahu, consisting of Navy Seabees and Army personnel. The first converted tanks were issued on Christmas Day, 1944, and the last on January 22, 1945. After the experiences on Iwo Jima using fire-hoses, three sets of 400ft standard 1.5in rubber fire-hose were provided to the battalion for attacking caves too remote for direct tank attack.

Aside from the conversion of the 713th Armored Flame Thrower (AFT) Tank Battalion, in late November the Fleet Marine Force requested 54 flame tanks, nine for each of the six

The periscope flamethrowers were the least popular type in the Pacific. Some tankers feared the device since it placed their faces so near to the flame gun. When it was fired, the flame was so bright that it completely obscured the target. Although dozens were deployed on Okinawa, few remained in service after half-hearted attempts at use. (NARA)

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Following the use on Peleliu of fire-hose attachments to extend the reach of flamethrowers into remote caves, POA-CWS tested their own assault flamethrower. The fire-hose connected to the flamethrower's fuel and pressure system through the commander's hatch and was directed through a standard portable M2 flame gun. This particular tank served as the pilot for the POA-CWS H5 flamethrower. (NARA)

divisions, and the Army's 27th Infantry Division requested the conversion of 12 light tanks into Satans. Because of the lack of resources, a decision was made that the 713th Tank Battalion would be used to support both Army and Marine units in the forthcoming Okinawa operation. The other units would have to make do with available supplies of auxiliary flamethrowers.

The Tenth Army wanted to issue periscope flamethrowers on a scale of 1–2 per tank platoon, but were informed by Washington that the E6R1 would not be available in time. As a result, they were issued the POA-CWS type. These were used to equip the 193rd and 711th Tank Battalions on Oahu in December 1944 on a scale of 18 per battalion. Further batches were delivered to other units earmarked for Okinawa, including the 706th and 763rd Tank Battalions on Leyte and the 710th Tank Battalion on New Caledonia.

The 713th AFT Tank Battalion first went into combat on April 19, 1945. The terrain on Okinawa was considerably different than on the volcanic Iwo Jima. Most of the fighting took place on southern Okinawa, which consisted of cultivated valleys dominated by high coral ridges. There was thick vegetation on most of the island, and the IJA built extensive defensive works into the hills, as well as using the traditional burial vaults which dotted the hills near the towns. As a result, much of the fighting took place against the heavily fortified ridge defense lines.

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M4 POA-CWS H1 MECHANIZED FLAMETHROWER, COMPANY C, 713TH ATF TANK BATTALION, OKINAWA, 1945

All of the tanks converted for this unit were based on late-production Detroit Tank Arsenal M4 tanks, sometimes called "composite hull" types, due to Chrysler's unique cast front and welded rear hull for the final production series of M4 75mm tanks. US Army tanks in the Pacific often had the standard Army Regulation 850-5 style of markings including a full set of white stars and standard bumper codes. The stars were often covered with paint or mud since they provided aiming points for enemy antitank gunners. Another common practice was the use of two-digit "speed numbers" which were used both for record-keeping and for tactical identification, in this case "90."

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The US Army's 713th Tank Battalion was the only tank unit completely equipped with flame tanks. This is an M4 with POA-CWS H5 main armament flamethrower of Company C, in action on Hill 95 in support of the 32nd Infantry, 7th Division on June 22, 1945, during attacks on caves believed to be connected to the Japanese main headquarters on Okinawa. (NARA)

The usual tactic was to assign a company of 18 flame tanks to an Army or Marine tank battalion which in turn further divided the flame tanks into platoons of six flame tanks for every tank company. Usually, a reinforced tank company would be assigned to an infantry regiment for key attacks. The Marines developed tactics called "corkscrew and blowtorch" to grind through the Japanese defenses. Each defense line was "processed" in a systematic fashion using tanks protected by riflemen. The tanks began by suppressing Japanese bunkers with direct tank fire and then cracking open the fortified defenses with tank guns before attack by flamethrower tanks. The aim was to clear an area about 500yd deep before proceeding on to the next zone where the process was repeated. The flamethrowers proved very effective in driving the Japanese defenders out of defensive works and trenches where they were then vulnerable to infantry, tank, and artillery fire. The Army's XXIV Corps reported that success against the Japanese defensive lines was dependent on "close-knit infantry-tank assault teams, infantry-demolition assault teams and infantry-flame-thrower assault teams." When attacking caves on sheer cliff faces, the fire-hose extensions were used with considerable success.

The E4-5 auxiliary flamethrowers had been criticized since they led to the removal of the bow machine gun. As a result, in January 1945, the Oahu team developed the POA-CWS-H4R2-H5 auxiliary flamethrower which permitted the flame gun to be mounted alongside the machine gun in a common weapon station. (NARA)

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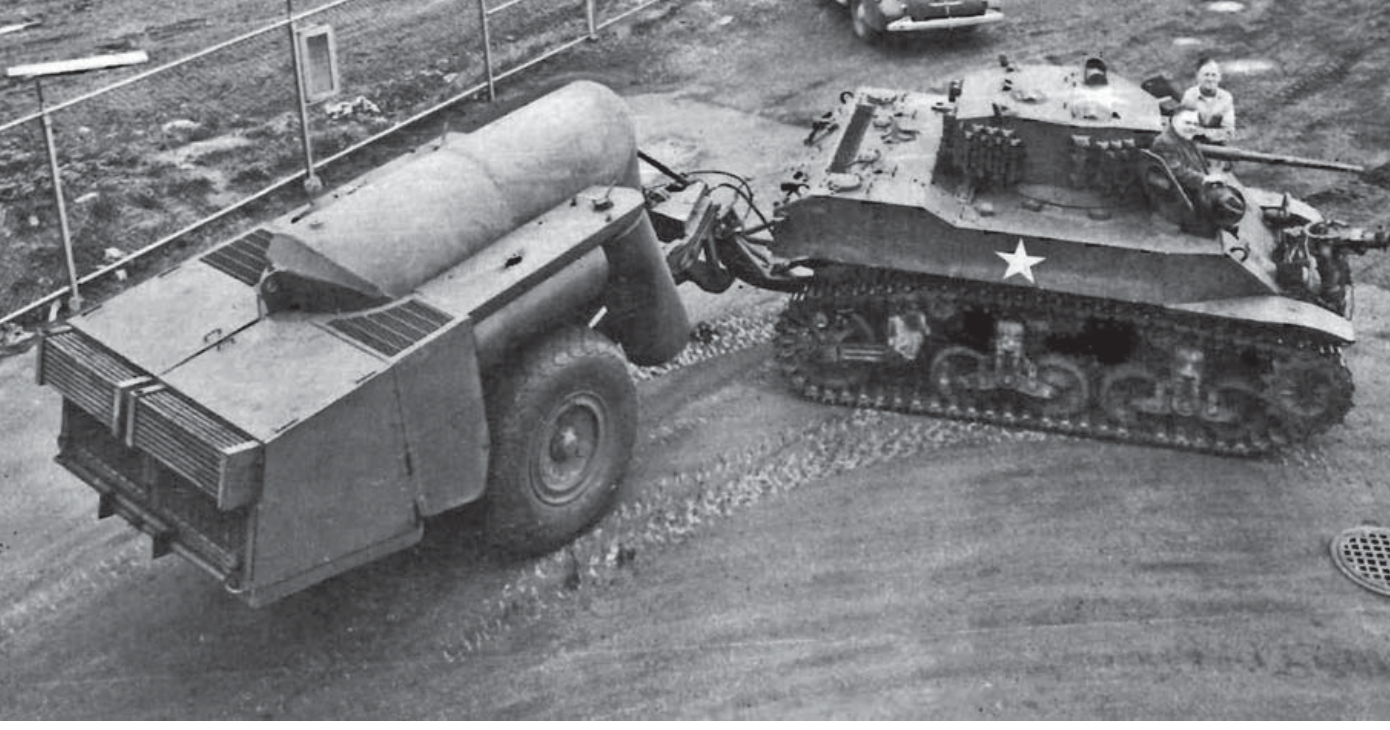

The most powerful auxiliary flamethrower developed during the war was the Indiana-Merz E9, mounted on the front of an M5A1 light tank. It had a maximum range of 200yd and the associated trailer carried 800gal of fuel as well as two compressors. An accident on May 29, 1944, in which four men were killed, led to an abrupt end to the program. (NARA)

The fighting in mid-May 1945 centered on the heights north of Shuri; the Japanese Thirty-Second Army headquarters was based under Shuri castle. During this fighting, the 713th AFT Tank Battalion was divided into separate companies, with Company A supporting the 7th Division, Company B the 1st Marine Division, and Company C the 77th Division. During May 1945, the battalion burned 49,000gal of fuel in their flame attacks. The fighting continued into southern Okinawa in the third week of June when the final organized Japanese defenses were overcome. During the course of the battle for Okinawa, the 713th AFT Battalion lost seven men killed and 112 wounded or missing; against this, the battalion was credited with killing about 4,800 Japanese troops. A total of 630 flame sorties were conducted, expending 199,950gal of fuel, mostly thickened fuel using 6 percent napalm. Of the battalion's 54 flame tanks, 41 were knocked out during the fighting, of which 26 were repaired and 15 were lost beyond repair. The most common source of tank losses was antitank guns and mines (eight each); one tank was lost at the outset of the campaign when it fell into a shell hole during the landing operation and had to be written off due to salt water damage.

Besides the 713th AFT Tank Battalion, most of the Army and Marine tank battalions had varying numbers of auxiliary flamethrowers, including the E4R2-5R1 bow gun mounting and the periscope flamethrowers. The 763rd Tank Battalion used an auxiliary flamethrower once without much effect. The 711th Tank Battalion had the periscope flamethrowers, but after two incidents the battalion removed the auxiliary flamethrowers. In one case, a tank was hit by Japanese artillery and a flamethrower unit exploded, killing three of the crew and wounding the other two. Another tank ran over a mine, and the fuel unit exploded. News of these incidents spread among the Army tank battalions. A later report stated that the Army tank units felt that "the range on the auxiliary flame tank was too short, the fuel capacity too small, and that they were afraid of it because of the increased fire hazard." After the campaign, the Army's XXIV Corps ordered that the auxiliary flamethrowers be removed and that main armament flamethrowers become the standard type.

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The only main armament mechanized flamethrower to reach series production in 1945 was the M5-4, with 151 completed. None reached combat, but they remained in service through the early 1950s, including this example at the Flame Thrower School, Armored Combat Training Center, Camp Irwin, California in June 1953. The flamethrower tank was designated as M42B1 when based on the M4A1, and M42B3 when based on the M4A3.

There was universal praise for the valuable contribution by the 713th AFT Tank Battalion. An Army observer's group reported that "the consensus of opinion of the using arm is that the armored flamethrower is a most valuable weapon, as it will kill the enemy or cause him to leave positions that no other weapon can reach. It is quite a morale builder to our own infantry. This was proven on numerous occasions as our infantry would move forward with the flame tank but not with standard tanks." The 17th Infantry, 7th Division reported that the flame tanks "were invaluable against enemy entrenched in coral formations, heavy undergrowth and in caves, driving them from these positions when all other means had failed ... in some cases flame tanks were the only weapons which could drive the enemy from positions." The 7th Division reported that the flame tanks "were outstandingly successful and of the greatest value" and recommended that in the future one company in each tank battalion attached to infantry divisions should be equipped with flame tanks.

The lessons of the Okinawa operation were a reaffirmation of the value of flamethrower tanks in the face of new Japanese defensive tactics. Technically, many tankers felt that the short-range and limited capacity of the auxiliary flamethrowers did not justify the danger of the fuel stowage. The large-capacity, long-range POA-CWS H-1 was much preferred, although the tank crews argued that it would be even better if it could be mounted coaxially with a 75mm gun, giving the tank the capability to use either weapon depending on the circumstances. POA-CWS was already working on a coaxial configuration.

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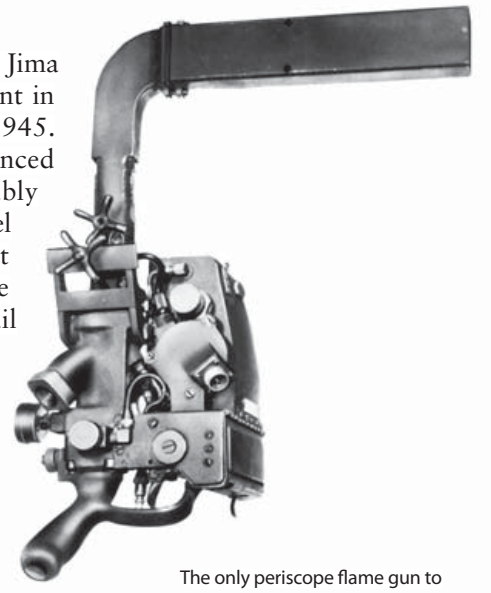
Operation *Downfall*: the invasion of Japan

The vital role of flamethrower tanks in the 1945 battles for Iwo Jima and Okinawa ensured that they would be an important element in the planned amphibious assaults against Japan later in 1945. Unmacht's POA-CWS team was already working on enhanced designs. In addition, the CWS at Edgewood had considerably ramped up its own development activity, assisted by the parallel NDRC programs. This book is limited to the flamethrowers that reached the production stage before the end of the war; there were many other experimental programs too numerous to detail in this short account.

The next major flamethrower effort by Unmacht's POA-CWS was an attempt to mount a high-volume, long-range flamethrower coaxially to the 75mm gun in the M4 medium tank so that the flame tank would have both weapons available. The flamethrower was mounted through the gunner's telescope opening on the left side of the gun, limiting the gunner to the use of the auxiliary periscopic gun sight on the turret roof. Production of the POA-CWS-H5 began in 1945 and the first examples were shipped to Okinawa. They did not arrive in time and were earmarked for the invasion of Japan. This type remained in service after the war with the US Marine Corps, and saw combat again in 1950 in Korea.



The only periscope flame gun to reach serial production besides the POA-CWS type was the M3-4-E6R3, with fewer than 200 built before the war ended. (NARA)

In August 1944, the Army requested that the CWS develop a standardized main gun flamethrower on a medium tank to replace the E7-7 on the M5A1 light tank. Standard Oil was given the task of developing the E12-7R1 mechanized flamethrower using the E7R1 flame gun based on the Model Q/E7 type. This was accepted for service use in 1945 as the M5-4 and 151 were completed out of 640 ordered when the contract was cancelled at the end of the war. This type remained in US Army service into the 1950s but did not see combat in World War II.

The POA-CWS H5 coaxial flamethrower remained in Marine service after the war, and prior to the Korean War was standardized on the M4A3 (105mm) assault gun with the new HVSS suspension. It served in Korea with the "Flame Dragons", the Flame Platoon, 1st Marine Tank Battalion and this one is seen near Hongchon on March 17, 1951. (NARA)

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The ultimate World War II US Sherman flame tank was the T33 Mechanized Flamethrower. This combined the heavily armored hull of the M4A3E2 assault tank with the new HVSS suspension, and a new turret with both 75mm gun and flamethrower. Three M4A3E2 tanks were rebuilt into this configuration in 1945, but the war ended before serial production began. (Patton Museum)

The CWS decided to take the POA-CWS-H5 concept one step further by mounting the weapon in the heavily armored M4A3E2 assault tank as the E20-20. Rather than simply rearm existing tank turrets, a new turret was developed for the Mechanized Flame Thrower T33. The T33 carried both an E20 flame gun as a coaxial weapon in the turret and an auxiliary E12R4 flame gun in the hull. Three pilots were built on existing M4A3E2 tanks, and plans were under way to build 300 new T33s starting in January 1946. By the time the war ended, the T33 was considered the most advanced US flame tank design but the construction contracts were cancelled at the war's conclusion.

Periscope flamethrowers were never very popular in the field, but work continued on this type at CWS in 1944–45. The final production type was the M3-4-E6R3, with 192 manufactured of the 500 ordered before the contract was terminated at the close of the war.

EUROPEAN THEATER

In contrast to the Pacific Theater, flamethrower tanks played an insignificant role in US armored operations in Europe. Portable flamethrowers were deployed in the early campaigns in North Africa, Sicily, and Italy, but were seldom used owing to the relative lack of fortifications in these campaigns. The lack of use of portable flamethrowers in the early 1942–44 campaigns in the Mediterranean theater provided little incentive for requests for tank-mounted flamethrowers. However, interest in flame tanks began to increase in 1943 because of British influence, the upcoming D-Day landings in Normandy, and expectations of fighting along the Siegfried Line.

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Lacking its own flame tanks, the first major combat experience of the US Army in the ETO was in September 1944 when British Churchill Crocodile flamethrowers of B Squadron, 141 RAC, 79th Armoured Division supported the 29th Division in its attacks against Fort Montbarey in the fortified port of Brest. (NARA)

Sherman Crocodile

On June 29, 1943, US, British, and Canadian officers held a flamethrower conference at Dumbarton Oaks, Maryland, to evaluate requirements for future mechanized operations in Europe, and especially for the forthcoming *Overlord* amphibious landings in France. The conference concluded that Britain led the US in mechanized flamethrower development. US officers were shown the Churchill Crocodile in March 1943 and told of the possibility of creating a similar flame tank using the M4 Sherman tank.[1] On August 11, 1943, the US Army informed the British War Office that it would have an estimated requirement for 100 Sherman Crocodiles. The British Petroleum Warfare Department proceeded with the construction of a wooden mock-up which was inspected by US officers on October 1, 1943. The first prototype was completed in January 1944 and began trials at the end of the month. The layout of the Sherman Crocodile differed from the Churchill version in that the flamethrower was mounted in a small turret on the right corner of the hull to permit the bow machine gun to be retained. The flame gun itself and the armored fuel trailer were the same as on the Churchill Crocodile.

A demonstration of the prototype Sherman Crocodile was held for US officers on February 3, 1944. The First US Army established a firm requirement for 65 in February 1944, and the formal requisition was increased to 115 on the presumption that Patton's Third US Army would require flamethrowers as well. The US requirement for the *Overlord* landings was for 100 Sherman Crocodiles, including 125 armored fuel trailers, and this was submitted to the British War Office on February 16, 1944. The first production example was completed in March 1944. The plan was for British firms to provide common items such as the armored trailer, while US firms would provide any other elements peculiar to the Sherman configuration. In the event, British factories were overwhelmed by work orders for the Churchill Crocodile, and barely managed to meet earlier British Army orders. As a result, no Sherman Crocodiles were ready for US Army employment on D-Day.

1 For further details on the Churchill Crocodile, see David Fletcher, *Churchill Crocodile Flamethrower*, Osprey New Vanguard 136, Oxford (2007).

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A soldier displays one of the new E5R1 auxiliary flame guns during demonstrations by the 70th Tank Battalion on September 13, 1944. (NARA)

Auxiliary flamethrowers in the ETO

With the Sherman Crocodile program already under way, in March 1944 the Armored Section of Eisenhower's US Army-ETO (ETOUSA) headquarters asked the Armored Force headquarters to arrange for the dispatch of a single E4-5 auxiliary flamethrower to Britain, followed by 100 more at a later date. The demonstration unit was promised for April 1944 with the expectation that a hundred E4-5 units for medium tanks and another hundred E5R1-5 units for M5A1 light tanks could be shipped by June 1, 1944. Tank officers wanted flamethrowers available for potential use against German Siegfried Line fortifications. On July 1, 1944, Gen Bradley's First US Army headquarters requested enough to equip each medium tank battalion with nine E4-5 flamethrowers. In the event, the first E4-5 was not shipped to Europe until June 12, 1944 with four more following on June 20. Four Sherman Crocodiles were delivered to the US Army in the UK in the summer of 1944, but the further production was cancelled on August 13 along with other specialized armored equipment originally intended for D-Day.

In early July, an E4-5 flamethrower was mounted in an M4 tank in Normandy for a demonstration to tank and chemical warfare officers from Eisenhower's ETOUSA headquarters. Its performance was described as "positively pathetic" compared to the Churchill Crocodile. At Gen Bradley's request, a special team was dispatched from the United States to demonstrate the proper use of the system and the next demonstration was held in Normandy on August 23 for officers from the First US Army and Patton's Third US Army. The modified M4 medium tank used thickened fuel, and this proved very effective in burning through local hedgerows. American officers familiar with the Canadian Wasp

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SHERMAN CROCODILE, 739TH TANK BATTALION (SPECIAL MINE EXPLODER), JÜLICH, GERMANY, OPERATION *GRENADE*, FEBRUARY 1945

The Sherman Crocodile was used on only a single occasion, during the reduction of the old citadel in Jülich in support of the 175th Infantry, 29th Division, on February 24. The town had been reduced to rubble by air attacks and artillery strikes, and the assault companies secured the town by late afternoon except for the old citadel. The fortress was surrounded by a moat 85ft wide and 20ft deep, and the division did not want to waste troops directly attacking it. So the Sherman Crocodiles were called forward to deal with the fortifications. Two of the tanks broke down before reaching the citadel. The remaining two reached the edge of the moat, and began pumping flame into the citadel, which forced the defenders to retreat underground. The M4 Crocodile flamethrower tanks then fired about 20 rounds of 75mm high explosive ammunition at the main gate, and once this was blown open, began flaming the inner courtyard. The last four German survivors fled the burning fort through tunnels and could be seen running away on the nearby hill. Troops from the 175th Infantry waded across the moat, securing it by 1500hrs. The fortress continued to burn for two days. The four M4 Crocodiles supported the 2nd Armored Division after the Rhine crossing in March 1945, but there were few other opportunities for the use of mechanized flamethrowers once the Siegfried line had been breached.

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Lt Gen George S. Patton snaps a photo during a demonstration of an E4-5 auxiliary flamethrower on October 25, 1944. Patton was not especially enthusiastic about the flamethrower, calling it just a "piddle" and "not hot enough." The kits allotted to his Third US Army were sent to depots and not deployed. (NARA)

flamethrower preferred that weapon due to its greater range. Although some thought was given to mounting the Wasp in the M4 medium tank, US officers realized that it would take too much time before the Wasp could be supplied to US forces so they settled on the E4-5 as better than nothing.

The Armored Fighting Vehicle & Weapon Section of Bradley's new 12th Army Group headquarters was more impressed by the second demonstration and on September 6, 1944 ordered 333 auxiliary flamethrowers, with 150 to be expedited since US units were quickly approaching the Siegfried Line. The overall objective was later extended to 630 flamethrowers by late 1944 and 1,012 by the end of January 1945, based on the expectation that each tank battalion would receive nine. The four E4-5 flamethrowers that had arrived in June were issued to the 70th Tank Battalion and used to begin familiarizing US tank troops with the new weapon. Two of these were loaned to the 741st Tank Battalion and there was at least one instance of combat use on September 15, 1944, against a Westwall bunker, with indifferent results. It should be noted that the later supplies to the ETO were actually the E4R2-4R3-5R1 system which included the improved E5R1 flame gun, an E4R3 transmission fuel group mounted on the transmission, and an E4R2 sponson fuel group. However, many unit records refer to the various types of auxiliary flamethrowers under the generic "E4-5" designation because of the awkward and unwieldy CWS flamethrower nomenclature.

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The crew of an M4A3(76mm) of the 774th Tank Battalion test an E4R2-4R3-5R1 installed on their tank in Luxembourg on November 17, 1944. (NARA)

The lack of flamethrowers led the Ninth US Army to request British flame support during the reduction of the fortified port of Brest in Brittany in September 1944. A dozen Churchill Crocodiles arrived and were employed in the attacks against defenses around Ft Montbarey. An after-action report noted that they "contributed materially in softening unusually stubborn resistance ... its demoralizing effect gives a 'shock action potential' far in excess of that possessed by the standard tank." One infantry lieutenant remarked, "I have seen the time when I would have given a million dollars for just one of those things for ten minutes. Where in the hell have the Americans been?"

"Siegfried Line" was an Allied misnomer for the Westwall fortified belt that had been erected along Germany's western frontier in the 1930s. The German Army had abandoned the Westwall line after the 1940 defeat of France and disbanded the many specialized fortification units. In August 1944, a crash program began to rejuvenate the bunkers as part of the new West-Stellung defenses.[2] The first section encountered by the First US Army near Aachen in early September 1944 was unoccupied and quickly overrun. As the US Army began to envelop Aachen, Hitler insisted that the city be held at all costs, and so the Westwall defenses along the Wurm River northwest of Aachen were fully occupied when attacked by the US XIX Corps starting on October 2, 1944. None of the promised tank flamethrowers had arrived by then, though portable flamethrowers were used in the reduction of the defense line.

2 For further details on the state of the Westwall in 1944, see Steven Zaloga, *Defense of the Rhine 1944–45*, Osprey Fortress 102, Oxford (2011).

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British flamethrower tank units were seconded to the Ninth US Army on two occasions due to the shortage of US main armament flamethrowers in the ETO. Here, a Churchill Crocodile of Squadron B, 1st Fife and Forfar Yeomanry, 79th Armoured Division conducts a demonstration near Merkstein, Germany on December 3, 1944. The squadron had been assigned to support the 2nd Armored Division during the Operation *Queen* push towards the Roer River a few weeks earlier. (NARA)

Due to the delay in receiving the E4-5 flamethrowers, Bradley's 12th Army Group experimented with some Wasp flamethrowers obtained from neighboring British and Canadian units. One was mounted in a half-track and used for a demonstration on November 7, 1944. The observers were impressed with the flamethrower, but felt that the vehicle was too vulnerable.

The first shipment of 50 auxiliary flamethrowers arrived in England on October 10, 1944, but when they reached Belgium on November 6 it was realized that they were lacking the transmission fuel unit, and so were limited to 25gal of fuel. The missing parts were expedited so that by mid-November Bradley's 12th Army Group had received 150 complete flamethrowers. The allocation was 75 to Hodges' First US Army (FUSA), 45 to Simpson's Ninth US Army (NUSA), and 30 to Patton's Third US Army (TUSA).

The heavier allocation to FUSA and NUSA was due to their engagements along the German frontier in November 1944, facing the remnants of the Westwall. However, by the time that the flamethrowers became available, the First and Ninth US Armies were heavily committed to the Operation *Queen* offensive towards the Roer River. Many tank units were reluctant to pull tanks and troops out of the line to refit with flamethrowers. A small number were used in the November 1944 fighting with inconsequential results, and progress on deploying the flamethrowers remained slow. The start of the German Ardennes offensive on December 16, 1944 also contributed to the delays in the First US Army, since it bore the brunt of the German attack. Patton's Third US Army showed very little interest in mechanized

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The Sherman Crocodile had the flame gun mounted in a small turret on the right front corner of the hull. The metal rod projecting from the flame gun was used to aim the device. (NARA)

flamethrowers in spite of its extensive fighting in the Metz fortified sector in October–November 1944. The new flamethrower equipment arrived after the Metz fighting and was not ready when the Third US Army penetrated the Westwall around Saarbrucken in the Saar in early December 1944.

Of the three field armies of Bradley's 12th Army Group, Simpson's Ninth US Army showed the most enthusiasm for flamethrower tanks. It had received some of the earliest flame support from Churchill Crocodiles in the fighting at Brest, and as a result had submitted a requirement in November 1944 for Crocodile flamethrowers. This rescued the four Sherman Crocodiles from limbo in the UK, and they were sent to the 739th Tank Battalion (Special Mine Exploder) in November 1944. More Sherman Crocodiles were requested but production never resumed. As an expedient, Churchill Crocodiles of Squadron B, 1st Fife and Forfar Yeomanry were assigned to the 2nd Armored Division of the Ninth US Army in mid-November 1944 to assist during the Operation *Queen* push towards the Roer River, to help deal with remaining segments of the Westwall in this sector.

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Sherman Crocodile flamethrower tanks of the 739th Tank Battalion (Special Mine Exploder) during their combat debut on February 24, 1945. These two tanks took part in the attack on the Jülich citadel. (NARA)

In December 1945, the 709th Tank Battalion, Ninth US Army, made limited use of two flamethrowers during the fighting near Vossenack in the Hürtgen forest. By mid-January 1945, Ninth US Army had received 55 flamethrowers of which 29 had been installed, only nine of which had the full double fuel tank arrangement. Both the 736th and 743rd Tank Battalions used the auxiliary flamethrowers in the February–March 1945 Roer River offensive. The Sherman Crocodile was used on only a single occasion, during the reduction of the old citadel in Jülich on February 24, 1945, as part of the Operation *Grenade* offensive.

Lt Gen Jacob Devers' 6th Army Group, fighting in Alsace, was the most isolated from the flamethrower shipments. The start of the German *Nordwind* offensive there on January 1, 1945 further delayed installations. Curiously enough, Operation *Nordwind* was one of the few occasions when the Germans used mechanized flamethrowers against US troops in the ETO, using two companies of Flammpanzer 38(t) against Maginot line forts near Bitche. A single flame tank of the 14th Armored Division was used in January 1945 during the reduction of the German pocket near Gambsheim and in one instance about 20 Germans surrendered even before the flamethrower had reached their positions. The results of this limited use were positive enough to encourage further conversion, but by February 23, 1945, only 19 had been installed. There was a surge of activity in Alsace in the late winter since the planned March 1945 offensive into the Saar was expected to encounter one of the remaining fortified belts of the Westwall, in the Wissembourg Gap area. The March offensives found the German Amy in a much depleted state, and the final sectors of the Westwall in the Saar were

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overcome by the Third and Ninth US Armies with very little use of mechanized flamethrowers. In total, some 726 E4R2-4R3-5R1 auxiliary flamethrowers were shipped to the ETO from June 1944 to March 1945, although only a fraction of these were ever mounted in tanks.

The minor role played by flame tanks in the ETO was due to a variety of factors. They were not available in time to take part in the autumn 1944 penetration of the Westwall, the one instance where they might have been most useful. The Germans had been the pioneers of flame weapons in World War I and the Westwall bunkers were designed to resist flame attack through the effective sealing of embrasures and doors, and the use of dispersed and protected ventilation systems. Tank officers in the ETO complained that the E4-5 was too short-ranged, and the German tactic was to defend bunkers with *Panzerfaust* teams to prevent the approach of flame tanks. When the

This is a heavily sand-bagged M4 of the 191st Tank Battalion, Seventh US Army, in Alsace shortly after an E4-5 auxiliary flamethrower was fitted to the bow-machine gun mount in February 1945. The crew is recharging the flamethrower with compressed air and fuel. The Seventh US Army attacked sections of the Westwall in the Saar region in March 1945 and there was some small-scale use of mechanized flamethrowers in these operations. (NARA)

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Some World War II flamethrower equipment remained in service and saw combat use again in Korea. This M4A3E8 of Company C, 89th Tank Battalion is using its auxiliary flamethrower to attack a Chinese pillbox in Korea on March 9, 1951. (MHI)

flamethrowers finally became available in significant numbers in early 1945, most of the Westwall defenses had been overcome except in the Saar. The E4-5 was mechanically and electrically unreliable, especially in the hands of crews with very limited training. The reliability issues could have been overcome if the troops had felt that flamethrowers were badly needed, but there was little demand for mechanized flamethrowers in this theater. Consolidating the flame tanks in a specialized battalion would also have helped with the maintenance problems, since it could have concentrated the necessary support and maintenance equipment such as fuel mixers, as well as ensuring more thorough crew preparation.

COMPARATIVE TECHNICAL SPECIFICATIONS

	E4-5	E4R4-5R5-5R1	POA-CWS E4-H1	Satan	E7-7	USN Mk I	POA-CWS-H1
Type	Auxiliary	Auxiliary	Auxiliary	Main armament	Main armament	Main armament	Main armament
Location	Bow gun	Bow gun	BOG periscope	M3A1 turret	M5A1 turret	LVT hull	M4 turret
Discharge rate (gal/sec)	0.6	1.0	0.7	1.5	2.4	2.4	1.9
Firing time (sec)	40	50	35	110	50	90	150
Fuel capacity (gal)	25	50	25	170	118	220	290
Compressed gas propellant	Air	Air	CO_2	CO_2	Nitrogen	Nitrogen	CO_2
Fuel	4.2% napalm	4.2% napalm	6% napalm	Bunker C/ fuel oil	7% napalm	7% napalm	6% napalm
Range (yd, thickened fuel)	70	70	50	80	135	115	80

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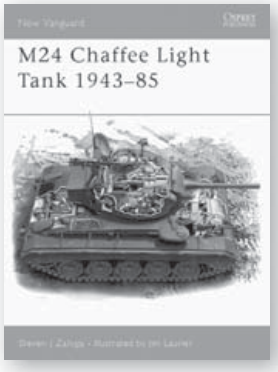

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ABBREVIATIONS

AEF	American Expeditionary Force
AFB	Armored Force Board
AFT	Armored Flame Thrower
AFV&W	Armored Fighting Vehicle & Weapon Section
AGF	Army Ground Forces
CWS	Chemical Warfare Service
ETO	European Theater of Operations
ETOUSA	European Theater of Operations – US Army
IJA	Imperial Japanese Army
LCM	Landing Craft, Mechanized
LCVP	Landing Craft, Vehicle and Personnel
LVT	Landing Vehicle, Tracked
NDRC	National Defense Research Committee
OSRD	Office of Scientific Research and Development
POA-CWS	Pacific Ocean Area-Chemical Warfare Service
SWPA	Southwest Pacific Area

EDITOR'S NOTE

For ease of comparison please refer to the following conversion table:

1 mile = 1.6km
1yd = 0.9m
1ft = 0.3m
1in = 2.54cm/25.4mm
1 gallon = 3.8 liters
1lb = 0.45kg